2019-nCoV importation risk to Europe

Report #2 [Report #1]

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NOTE: This is a brief report with preliminary estimates based on limited information available. Updates will follow as the situation evolves.

26/01/2020 (DATA UP TO 25/01/2020)

CURRENT SITUATION

Starting December 2019, cases of pneumonia of unknown etiology were reported in the city of Wuhan, in the province of Hubei in China [1]. The infective pathogen was later identified to be a novel coronavirus, called 2019-nCoV [2].

As of 25/01/2020, a total of 1,297 confirmed cases were reported from China [3]. The main affected area is in the province of Hubei, but other 32 provinces reported confirmed cases [4].

Thirty-two confirmed cases were exported out of China, with 22 cases (69%) imported in Asia, 4 (13%) in Oceania, 3 (9%) in Europe, and 3 (9%) in North America [5]. In Europe, all 3 cases were imported in France. They were confirmed on 24/01/2020, with travel dates on 18/01/2020 (2 cases) and 22/01/2020 (1 case). In a step to contain the viral spread, Chinese authorities enforced travel restrictions in the province of Hubei starting on 23/01/2020 (3AM Central European Time), including a complete ban on international flights [6].

AIM & METHODS

Following the importation of the 2019-nCoV confirmed cases in France, we update our estimates of the risk of importation of 2019-nCoV cases to Europe from infected areas in China by air travel (see report #1).

Due to the travel ban put in place in the province of Hubei, we consider as possible seeds of case exportation out of China 18 cities predicted to be at high risk (see map) due to their internal connectivity to Wuhan. These cities were identified in a 25/01 report by the University of Southampton that analyzed de-identified and aggregated domestic population movement data (2013-2015) derived from Baidu Location-Based Services to estimate the risk of 2019-nCoV spread within Mainland China around the

New Lunar Year migration [7]. They were found to be highly correlated with the number of reported cases in the corresponding provinces [4,7].

This seeding further expands the multi-source seeding we considered in our report #1 to account for the evolving situation. For sensitivity, we also tested the additional inclusion of Wuhan in the multi-source seeding.

Map of Chinese provinces color coded according to the number of cases [4]. The 18 cities selected for the multi-source seeding are shown with black dots. Wuhan (grey dot) is not considered as a seed due to the current travel ban.

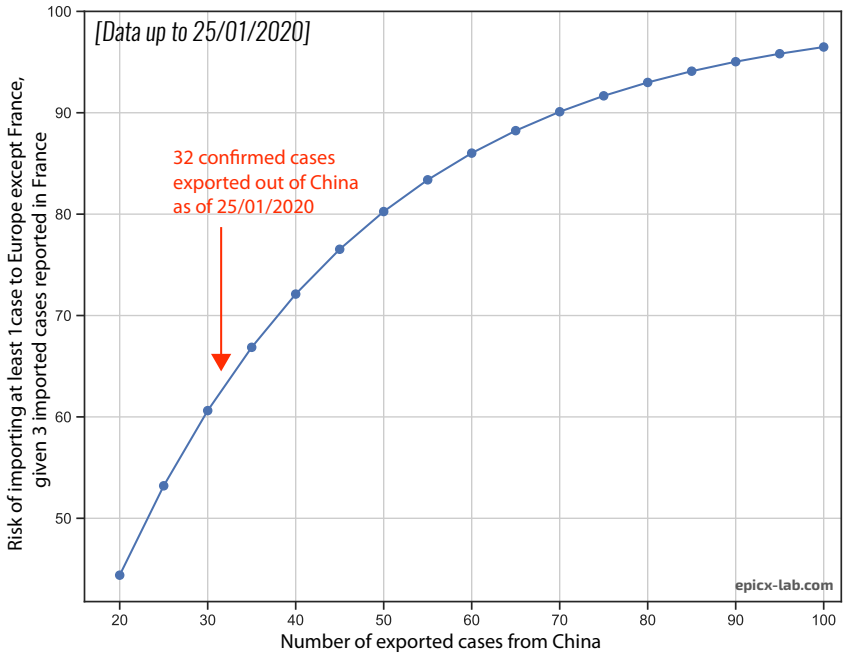
We estimate the risk of *importation to Europe except France* as the probability that Europe (France excluded) imports travel-related cases from China, conditioned to the observation of 3 cases imported to France. The computation of the risk to European countries is based on estimates from the platform EpiRisk [9] and accounts for origin-destination air travel flows of January from 2019 OAG database of the GLEAM Project [9-11]. The Appendix provides the details of the computation of the conditioned probability. We estimate the risk for a varying number of exported cases from China, given the current difficulty of assessing the likelihood of exportation from China due to limited data.

We then provide a color-coded map of Europe to report the country-specific risk of importation if a case is imported to Europe.

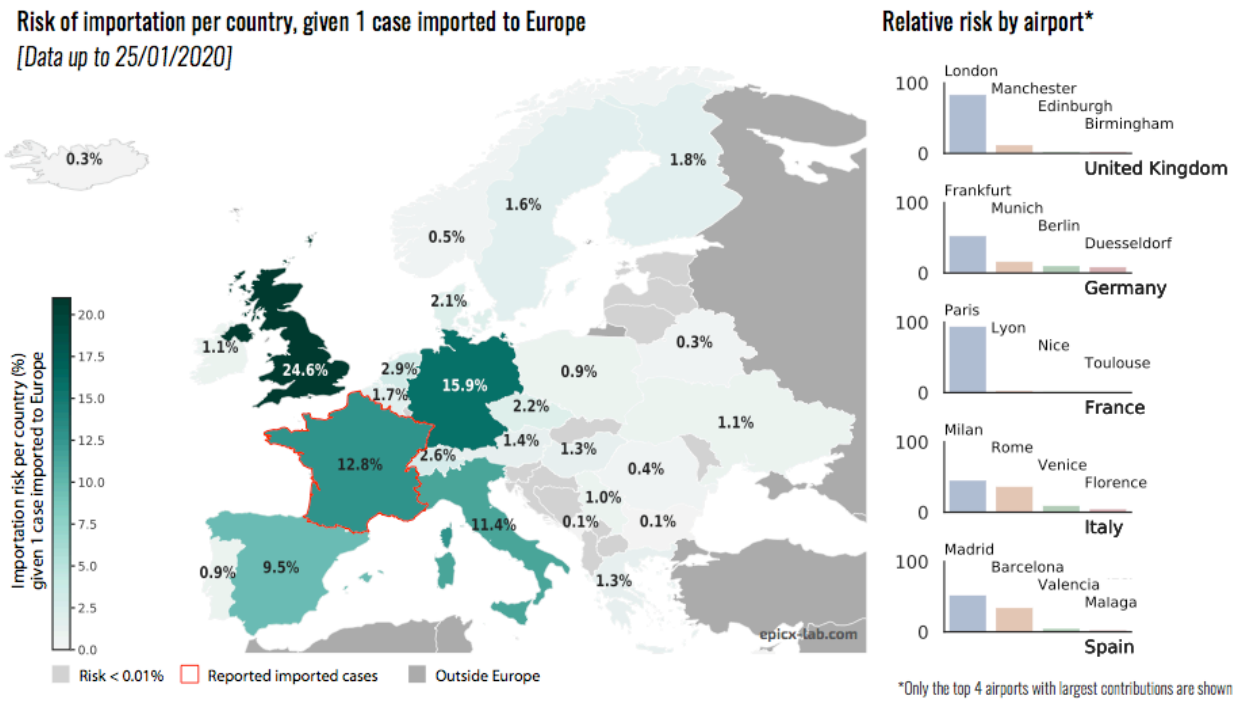
Updates from report #1:

- The multi-source seeding is updated according to latest reports [4,7].
- The risk of importation to Europe is conditional to the 3 cases imported in France [3].
- The risk estimate is now provided for all European countries, not only for EU-28 Member States as done before.
- The risk map now shows the risk that a European country would import a case, given that the case travels to Europe. A different color code for this new quantity is used to distinguish it from the maps of the previous report.

ESTIMATED IMPORTATION RISK FROM INFECTED PROVINCES IN CHINA



The probability that at least 1 case is imported to Europe except France, given the 3 imported cases reported in France, is moderate to high. It is estimated to be more than 60% for the number of travel-related exportations from China reported so far (32 cases). The probability becomes larger than 80% if 50 cases are exported from China.



In the event that 1 travel-related case is imported to Europe, the risk of importation is highest in the UK (25%) and Germany (16%). France would have a probability equal to 13% to receive another case. Italy (11%) and Spain (9.5%) rank as fourth and fifth in the risk.

For the top 5 countries at higher risk of importation, histograms display the airports that are most likely to import cases (only the 4 top airports are displayed for the sake of visualization). In some countries, importations are likely to occur at multiple airports (e.g. Germany and Italy), whereas in others the risk is mostly concentrated in airports serving the capital city (e.g. in the UK, where London contributes to 83% of the risk, and in France, where Paris contributes to 94% of the risk).

The estimates account for the travel ban imposed in the province of Hubei. Including travel flows from Wuhan, to account for cases that may have flown before the travel ban and are not yet detected, does not alter the estimations.

CONCLUSIONS

France just reported the importation of three 2019-nCoV confirmed cases from China. They are still the first and only imported cases confirmed in Europe. We estimate that the risk of importation of at least 1 case to Europe but France is high. It is larger than 80% if 50 travel-related cases are exported from China. Cases are most likely to be imported in the UK and Germany, confirming our previous estimates and those reported by other groups [7,9,11]. It is possible that cases have already been imported in other European countries besides France, and that they have not been reported yet due to a delay from importation to confirmation. For example, all 3 cases imported to France were confirmed on 24/01/2020, with 2 traveling on 18/01/2020 and 1 on 22/01/2020.

Our results are based on available data and estimates of the affected provinces in China and account for origin-destination travel fluxes from these provinces, as well as the travel ban enforced in the Hubei province. However, estimates are sensitive to different health-seeking behaviors that infected travelers may have, and to the active surveillance practices put in place in European countries. We did not provide estimates of the expected number of imported cases per country, as this depends on the number of travel-related exported cases from China, a variable that is still hard to assess at this early stage.

Risk maps will need to be rapidly updated as the outbreak situation evolves.

APPENDIX – CONDITIONED PROBABILITY

Let us define:
n : number of cases exported from China;
x : number of cases exported to France;
y : number of cases exported to Europe excluding France;
z : number of cases exported outside Europe.
The respective single-event probabilities we compute are p_x, p_y, p_z. From conservation, $p_x+p_y+p_z = 1$, and $x + y + z = n$. We compute $P(y = 0|x = c)$. This is

$$P(y = 0|x = c) = \frac{P(y = 0, x = c)}{P(x = c)}.$$

The probability at the denominator is binomially distributed: $P(x = c) \sim Binom(p = p_x, N = n)$.
The probability at the numerator comes from the multinomial distribution
$P(x, y, z) \sim Multinom(p = [p_x, p_y, p_z], N = n)$.
By setting $x = c, y = 0, z = n - c$ in this latter formula, we get:

$$P(y = 0, x = c) = \binom{n}{c} p_x^c p_z^{n-c}.$$

Putting together, we get

$$P(y = 0|x = c) = (\frac{p_z}{1 - p_x})^{n-c}.$$

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